Cont'd A1

52. The electron source of Claim 51, wherein the substrate comprises an insulating layer and a conductive layer.

53. The electron source of Claim 52, wherein at least one barrier is formed within the conductive layer of the substrate.

54. The electron source of Claim 51, wherein the substrate is a single crystal with (111) orientation.

55. The electron source of Claim 51, wherein the field emitter comprises at least one semiconductor material.

56. The electron source of Claim 51, wherein at least one barrier is formed, in part, by an insulating layer that is perpendicular to the direction of charge carrier flow.

57. The electron source of Claim 51, wherein the different materials are semiconductors with opposite conductivity types.

58. The electron source of Claim 51, wherein an end of the field emitter comprises a narrow tip.

59. The electron source of Claim 58, wherein the tip of the field emitter is sharpened and coated by diamond or diamond-like material.

60. The electron source of Claim 59, wherein the diamond or diamond-like material is sharpened.

61. The electron source of Claim 51, wherein the field emitter comprises two coaxial parts, a broad inner part and a more narrow outer part.

62. The electron source of Claim 51, wherein the barrier is formed within the field emitter body.

63. The electron source of Claim 51, wherein the barrier is formed between the field emitter body and a conducting layer placed directly on a surface of the field emitter.

64. The electron source of Claim 63, wherein the conducting layer comprises at least one semiconductor material.

65. The electron source of Claim 63, wherein there is an insulating layer at least part way between the conducting layer and the surface of the field emitter.

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66. The electron source of Claim 51, wherein the source of the charge carriers is the conducting layer on the surface of the field emitter.

67. An electron source comprising:

a substrate;

a field emitter, a body of the field emitter configured as a blade;

a source of charge carriers supplying the field emitter; and

at least one ballast resistor configured as a junction between semiconductor materials with opposite conductivity types located in or proximate to the field emitter.

68. The electron source of Claim 67, wherein the substrate is a single crystal with (111) orientation.

69. A controlled electron source comprising:

a substrate having a surface and a field emitter extending from the surface;

a field emitter having a side surface with an insulating layer covering at least a portion of the side surface;

a source of charge carriers supplying the field emitter;

at least one ballast resistor configured as a junction between materials with opposite conductivity types located in or proximate to the field emitter; and

at least one control electrode in proximity to the junction.

70. The controlled electron source of Claim 69, wherein the field emitter, having a body, contains at least one active area that is at least, in part, in the body.

71. The controlled electron source of Claim 69, wherein a conducting layer covers at least part of the surface of the substrate and at least part of the surface of the field emitter, the layer containing at least, in part, one or more active areas.

72. The controlled electron source of Claim 69, wherein at least one control electrode is placed close enough to the junction to influence a flow of charge carriers therein.

73. The controlled electron source of Claim 69, wherein at least one control electrode is separated from the field emitter by a vacuum gap.

74. The controlled electron source of Claim 69, wherein at least one control electrode is placed along the side surface of the field emitter.

91 Continued

75. The controlled electron source of Claim 74, wherein the control electrode has direct contact with the side surface of the field emitter.

76. The controlled electron source of Claim 69, wherein a surface of the field emitter is coated by a material which is transparent to electrons, and which prevents outlet of chemical elements from the field emitter.

77. The controlled electron source of Claim 76, wherein the material comprises diamond or diamond-like carbon.

78. A matrix system of controlled electron sources arranged on a substrate comprising:

at least two controlled electron sources; and

parallel rows of conductive material on an insulating layer covering the substrate.

79. The matrix system of Claim 78, wherein the system is a two-dimensional array of the controlled electron sources arranged in rows that are approximately perpendicular to one another.

80. The matrix system of Claim 78, wherein the controlled electron sources receive electrical input from two sets of approximately parallel conductive buses that are approximately perpendicular to each another and that are separated from each other by an insulating layer.

81. The matrix system of Claim 78, wherein at least one control electrode has a diaphragm shape and comprises conductive diamond or diamond-like material.

82. A method of preparation of a controlled electron source comprising:

forming the field emitter as a whisker epitaxial to the substrate;

forming within the field emitter at least one junction between materials having opposite electrical conductivity, the boundary configured approximately perpendicular to a long direction of the whisker; and

forming at least one control electrode close enough to the junction to affect junction conductivity when a voltage is applied to the control electrode.

83. The method of Claim 82, wherein forming the field emitter as a whisker is done using a vapor-liquid-solid method.

84. The method of Claim 82, wherein forming the field emitter as a whisker comprises forming a cavity in the substrate; and depositing a solvent particle at a bottom of the cavity.

85. The method of Claim 82, wherein the forming of the field emitter on a substrate comprises placing a solvent particle on the substrate and etching the substrate around the solvent particle.

86. The method of Claim 82, wherein forming the field emitter on a substrate comprises:

depositing a solvent particle onto the substrate, the substrate having a first conductivity type;

using a first source material having a second conductivity type opposite to the first conductivity type to grow a portion of a whisker having a second conductivity type;

cooling the whisker, having a globule on its end, and also cooling the substrate using an inert gas;

removing the first source material;

heating the whisker having the globule on its end using an inert gas and the substrate; and

using a second source material having a first kind of conductivity to continue growing the whisker, thereby making a portion having the first conductivity type.

87. The method of Claim 86, wherein additional portions of the whisker are formed with alternating second and first conductivity types.

88. The method of Claim 82, wherein forming the field emitter comprises:

growing a whisker in a gas atmosphere that comprises elements of the substrate;

introducing doping gases into the gas atmosphere; and

changing the conductivity type of the doping gases at least once while forming the field emitter.

A1
Concluded